CCMR Educational Programs

Title:	**Paper or plastic?**
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Appropriate Level:	Science courses: grades 9-12
Abstract:	This lesson, would educate students as consumer of plastics. They will learn the basic chemistry of plastics, their environmental effects, and the possible solutions to the problem of pollution by plastics.
Time Requirement:	One 75 minute block to introduce the material. One 75 min block to debate the proposition to ban plastics bags in super markers in the community.
NY Standards Met:	● Standard 6—Interconnectedness: Common Themes Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning. *Key Idea 1: System thinking*--Recognize how interrelated parts of the earth system are affected by pollution *Key idea 2: Optimization* --In order to arrive at the best solution that meets criteria within socio-economic constraints, it is often necessary to make trade-offs. ● Standard 7—Interdisciplinary Problem Solving Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions *Key Idea 1:Connections*--Evaluate the environmental consequences of consuming petroleum based plastics *Key idea 2: Strategies* – develop a module for plastic education to be used in middle or elementary school
Materials:	Pen, pencils, large sheets of paper, markers. Handouts 1-6 Optional: computers with internet access, LCD projector
Sections to Document:	Background Purpose Materials Introduction to the module Teaching Strategy Part I: Plastics, the basics Part 2: Town Meeting Assessment Extensions References Acknowledgments Attachments – handouts 1-6

PAPER OR PLASTIC?

Background

Plastics play an important role in almost every aspect of our lives. Plastics are used to manufacture everyday products such as grocery bags, beverage containers, household items, and furniture; some people say that we live in "The Plastic Age". Most plastics today are made from declining sources of petroleum; yet global demand for plastics products in growing exponentially. Scientists are developing plastics made of renewable and biodegradable material; some of those products are already in the market. Plastics deteriorate very slowly into chemicals that pollute air, soil and water. Pollutants from plastics pose serious treats to the environment and to human health. To manage the problem of plastic pollution, some communities have passed bans on plastic grocery bags. Through this exercise, you will learn basic information about plastics, and take a position in a discussion of plastic grocery bags in your community.

Purpose

Students will understand:

The history of polymer science
How plastics are made; types of plastics and their uses
Plastics recycling
Environmental effects of plastics
Effects of plastic pollution on human health

Student will be able to:

Take a position in a debate discussing a ban on plastic grocery bags in our community.

Materials

- Copies of handouts 1-7
- Large sheets of butcher paper
- Felt-tip pens
- Computers with internet access, and LCD projector-- optional

Introduction to the module

This module will be take two 75 min sessions. Students will get handouts with summaries of information about plastics. They will research subtopics assigned, prepare public presentations, and assume roles in a mock town meeting. Copies of readings are attached. If access to internet is available, the web sites provided can be used as portals to conduct extended investigations.

A week prior to the lesson, students will collect all plastic trash including plastic grocery bags at home. They will bring the plastics accumulated in seven days to school. These plastics will be used to discuss recycling.

Teaching Strategy:

Students are divided in groups. Each group will discuss assigned material, write a summary on a piece of butcher paper, and present that to the class.

Part I: Plastics, the basics
Objective:
Students learn basic information about plastics.

Introduction:
Students brainstorm and write a quick list of all the items made of plastic they would encounter during one day. Compare lists, build and post a class list..
Students answer the question "Would you be willing to give up plastics?"

Procedures:
Divide students in five groups.
To make an informed decision, students need to know what plastics are, their uses, and their effect on the environment. The teacher will ask you to choose one section to read. Discuss that information within the group, and write a summary on a piece of butcher paper. Address the following points:

1. Brief History of plastics: Handout 2a
   - Pre- 1800's
   - Late 1800's
   - Early 1900's
   - Late 1900's
   - Plastics today

2. How plastics are made. Handout 2b
   - Chemical nature of plastics
   - Mechanical nature of plastics
   - Plastic composites
   - Bio-based plastics

3. Plastics recycling in the US. Handout 3
   - Challenges and opportunities
   - Misconceptions about recycling
   - Resin chart

4. Pollution by plastics. Handout 4a and 4b
   - Sources of plastic pollutants in the water
   - Effects on marine environments
   - Effects on marine turtles, mammals and birds

5. Adverse health effects of plastics. Handout 5
   - Direct toxicity
   - Carcinogens
   - Endocrine disruptors

Assessment:
In class or as homework: summarize all information as tables, graphs, or thinking maps.
Assignment: Read handouts 6 and 7 and write a brief summary as a homework.

Part 2: Town Meeting to solve the problem of plastic bag pollution where environmental activists propose a ban on plastic grocery bags.

Objective:
Attend a mock Town Meeting. Assume a role, and take a take a position in favor or against banning plastic bags in supermarkets.

Introduction:
Brief review of handouts 6 and 7. What is the theme of these readings?

Now that you know some basic information about plastics, you will be asked to attend a Town Meeting to debate the problem of pollution caused by plastic bags. Environmental activists are proposing **a ban on plastic grocery bags in your community**. What is your position on this proposal? What do you propose as a solution?

Procedures:
Adapted from:
"Transnational Pollution: Why Are You Dumping on Me?" in Global Issues for the 90s. *Denver: Center for Teaching International Relations, University of Denver, 1993. pp 79-83.*

CBBC news round. Climate chaos week, citizenship, globalization, environmental implications March 03 2006

Explain that a debate is based around a proposal or motion. The debate will focus on the proposal to: ***ban plastic bans in grocery stores in our community.***

A debate has persons that support or oppose the proposed action. The class will be divided in seven groups. Students assume one of the roles listed below. The handouts have information that will help you to focus your ideas from that person's perspective.

1. Opposer-- Owner of Safe Food grocery stores – Handout 1
2. Opposer -- Chemist from The American Plastics Institute – Handout 2a and 2b
3. Opposer – Recycling company representative -- Handout 3
4. Supporter --Sierra Club member and environmental activist -- Handout 4a and ab
5. Supporter -- County Health Department Official – Handout 5
6. Supporter -- County Waste Management Department Official -- Handout 3
7. Speaker for the Town Board that will approve or disapprove the plastic bag ban -- Handout 1 and 6

The objective of this activity is to develop solutions and a course of action in response to the plastic pollution problem in the community. Each group will research and write down arguments that either support or oppose the proposal. When conflict occurs (and it will) among members of a group, they have to compromise and alter their positions to reach a group consensus. Only one person from each group will speak during the debate.

Rules for the Debate:
1. The debate is chaired by the Speaker, whose decision on all matters is final.
2. You can only speak ONCE during the debate. Your speech should be about two minutes long. If you can, develop an argument rather than making a single point.

3. But you can 'intervene' as many times as you like. To intervene is to ask a question about a point being made. (E.g. Are those statistics up-to-date?)
4. You can use notes to help you with your speeches and make notes during the debate.
5. If you want to speak during the debate, you should catch the Speaker's eye by standing up as soon as someone has finished speaking. The Speaker will pick someone from those standing up.
6. If you spot someone breaking these rules you should tell the Speaker. This is called a point of order.

Hold the debate in this order:

- The Speaker presents the motion.
- The first supporter presents the arguments for the motion.
- The first opposer presents the arguments against the motion.
- One of the supporters presents their arguments for the motion.
- An opposer presents their arguments against the motion.
- This side to side motion continues until everyone has had their say.
- A supporter sums up their group's main argument.
- An opposer sums up their group's main argument.
- Speaker designates one side of the classroom the 'yes' wall and the opposite side the 'no' wall.
- The Speaker re-reads the motion.

Students vote:

- Students vote to support or oppose the motion, depending on which they thought were the most convincing and well constructed arguments. This may not necessarily be what they believe personally. The Speaker can't vote.
- They vote by going to the 'yes' or 'no' side of the classroom.
- The two tellers count up the votes (bodies) on either side of the room.

The Speaker announces the result of the vote

Assessment:
After the debate, each student writes a personal statement of their opinions.
They pick five arguments that match their viewpoint and include them in a report that starts "I support/I oppose the ban on plastic bags because..."

As a class, discuss the following questions:

- What were some of the conflicts that your group experienced developing your course of action?
- What difficulties would different stakeholders face when deciding on a joint course of action to an environmental problem?
- What can be done to prevent further instances of plastics pollution?
- Is one type of pollution worse than another? Is one type more common?
- Who should be forced to pay for environmental clean-up -- government or private industry?
- How can communities work together to better the environment?

Extensions:

- Role playing activities are adaptable to any topic which has at its core some kind of controversy.
- This and other internet materials could be used to prepare a presentation appropriate for lower grades.
- Students can do in-depth research in a subtopic. Or the material presented here can be linked to other lessons as follows

1. Brief history of plastics -- Chemistry, history of science.
2. How plastics are made -- Chemistry, organic compounds, polymers.
3. Recycling of plastics in the U.S. -- Math, calculations and projections of amounts of plastics produced in the school or community. Projections of economic value of recyclables.
4. Pollution by plastics -- Earth Sciences, air, soil, water cycles, and global warming.
5. Pollution by plastics -- Biology, survey of local environments, create lists of species that may be affected by plastic pollution. Draw ecosystems diagrams.
6. Adverse health effects of plastics – Biology and Health, reproductive systems.
7. Languages. Writing of educational materials for lower grades or the public.
8. Social Sciences -- Organize a clean up around the community.
9. Arts -- designing flyers to promote a position. Preparing radio and television scripts promoting a position.

Internet Resources/References:

www.americanchemistry.com/s_plastics/doc.asp?CID=1102&DID=4665

http://www.plasticsresource.com/s_plasticsresource/sec.asp?TRACKID=&CID=92&DID=133

http://www.enviroliteracy.org/article.php/1268.html

http://www.enviroliteracy.org/article.php/1268.html

http://www.epa.gov/msw/plastic.htm

http://www.greenerchoices.org/products.cfm?product=plastic&pcat=homegarden

http://www.soynewuses.org/Plastics/Default.aspx

http://www.ecologycenter.org/ptf/misconceptions.html

http://www.plasticdebris.org/PRDS_Brochure_DOWNLOAD.pdf

http://www.treehugger.com/files/2007/07/plastic_pollution.php

http://www.botany.uwc.ac.za/Envfacts/plastic/index.htm

http://www.ecologycenter.org/factsheets/plastichealtheffects.html#plastichealthgrid

http://news.google.com/nwshp?sourceid=navclient&ie=UTF-8

http://www.nj.com/opinion/times/editorials/index.ssf?/base/news-0/11881876593800.xml&coll=5

http://news.bbc.co.uk/go/pr/fr/-/cbbcnews/hi/newsid_4610000/newsid_4617600/4617607.stm

Attachments

Hand out 1 -- Paper or Plastic?
Hand out 2a. History of Plastics
Hand out 2b. How Plastics Are Made
Hand out 3. Plastic Recycling in the US
Hand out 4a. Pollution by Plastics
Hand out 4b --The Problem with Plastic
Hand out 5. Adverse Health Effects of Plastics
Hand out 6a. Plastics in the News
Hand out 6b. Plastic Bags Bans in the U.S.
Hand out 7. An ocean awash in lethal bags, bottles, pellets, line, tarps and diapers.

Hand out 1 -- Paper or Plastic?

Read 8/28/07 http://www.enviroliteracy.org/article.php/1268.html

Shoppers have the opportunity to make a choice every time they make a trip to the grocery store: paper or plastic? Many consumers may wonder which type of bag is better for the environment. To assess the comparative environmental impacts of each material is not a simple matter; it requires consideration of the inputs of matter and energy throughout each stage of the life cycle of each product.

Plastics are produced from the waste products of oil refining. An analysis of the life cycle of plastic bags includes consideration of the environmental impacts associated with the extraction of oil, the separation of products in the refining process, and the manufacturing of plastics. The total environmental impact depends upon the efficiency of operations at each stage and the effectiveness of their environmental protection measures. Paper is produced from trees; environmental impacts include those associated with extracting timber and processing it for paper products. Again, the environmental impacts depend on whether the timber was obtained from a sustainably managed forest -- most industrial timber products in the U.S. come from plantations -- and the environmental management of the paper processing plant. Comparatively, plastic bags require less energy to produce.

Both paper and plastic bags have to be transported to stores, which requires energy and creates emissions. In this comparison, plastic is preferable because plastic bags are lighter in weight and more compact than paper bags. It would take approximately seven trucks to transport the same number of paper bags as can be transported by a single truck full of plastic bags.

The disposal of bags entails additional environmental impacts. If land-filled, plastic bags are more environmentally benign than paper, as they require less space; paper occupies approximately half of overall landfill volume. Plastics (not just bags) generate 14 to 28 percent of the volume of trash in general, but because much of it can be compressed, only 9 to 12 percent of the volume of waste in landfills. Although plastics do not biodegrade, modern landfills are designed in such a way that *nothing* biodegrades, because the waste is isolated from air and water in order to prevent groundwater contamination and air pollution. As manufacturers have continued to make their plastic packaging thinner and lighter to save materials, the percentage of landfill volume taken up by plastics has remained steady since 1970 even as plastics have become more widely used.

Not all trash ends up in landfills; in the U.S. about 80 percent does. Stray plastic bags, which have been estimated at one to three percent of the hundreds of billions that are produced each year, are now found almost everywhere on the planet. Although littering and trash laws in developing countries have significantly reduced the amount of improperly disposed trash, many developing countries have fewer trash receptacles, landfills, and programs to handle the increasing amount of trash.

Plastic bags pose a threat to marine life, because, if ingested, the bags can block the stomach and cause starvation. Sea turtles, for example, mistake plastic bags for jellyfish. In 2002 a minke whale that washed up on a beach at Normandy was found to have 800 grams of plastic and other packaging in its stomach. Stray plastic bags can also clog sewer pipes, leading to stagnant, standing water and associated health hazards. In 2002, Bangladesh banned plastic bags after drains blocked by bags contributed to widespread monsoon flooding in 1988 and 1998. Ireland has decreased plastic bag consumption by placing a consumer tax on plastic bags. Perhaps the most strict plastic bag regulations are found in the Indian province of Himachal Pradesh, where people caught with plastic bags are fined $2000 as a measure to protect sacred cows from ingesting them.

Hand out 2a. History of plastics

Read on 8/27/07 http://www.enviroliteracy.org/article.php/1268.html

Plastics were originally developed as synthetic substitutes for natural materials, such as rubber, tortoiseshell, and ivory, which were once widely used for consumer goods. The first commercially viable plastic was celluloid, developed in the latter part of the 1800's century as a replacement for ivory in billiard balls, combs, brushes, and other household items. Celluloid was made from cellulose nitrates: plant fibers were nitrated in acid to form nitrocellulose, which could then be molded into various shapes. It was later used as the substrate for flexible photographic film, making motion pictures possible. Cellulose was also molded into thin sheets, cellophane, used to package consumer products. Rayon, also produced from plant fibers, was developed in 1891. The first synthetic plastic, Bakelite, was developed in 1907 by Leo Baekeland through a condensation reaction of phenol (derived from coal tar) and formaldehyde.

Wallace H. Carothers, head of a research laboratory at Dupont, led a team that was the first to synthesize long-chained molecules, called polymers, in the lab by combining alcohol and esters. Carothers was trying to prove that polymers were, in fact, long-chained molecules, not aggregates of molecules as previously thought. In a two week period in 1930, Carothers and his team discovered neoprene, a synthetic substitute for rubber, and nylon, a synthetic fiber.

Research into plastics accelerated during World War II to meet the demand for strong and lightweight materials for military purposes. Acrylic plastic was not significantly utilized until there was a wartime demand for aerodynamic sheets that could be used to cover airplane cockpits, although acrylics first appeared on the market in the 1930s. The annual volume of plastics produced tripled during the period of 1940 to 1945.

Although plastics were first developed as a substitute for natural materials, industrial designers began to design products based on the characteristics of the new materials. Plastics made it possible to make brightly colored products, in addition to products with rounded corners, which was difficult to do with wood or metals. Products made of plastic became a prominent component of the Art Deco and Art Modern movements in the 1920s and 1930s. After World War II, plastics were used to make an endless number of relatively inexpensive consumer products, including linoleum, formica, and other household goods. Plastics also made toys inexpensive, such as the hula hoop and the Barbie doll, which was introduced in 1959.

Plastics also can be custom-designed for innumerable uses, including *polyethylene terephthalate* for soda bottles, high-density *polyethylene* for milk bottles, *polypropylene* for ketchup bottles, *expandable polystyrene* for egg crates, *low-density polyethylene* for plastic bags, and *polyvinyl chloride* (PVC) for water pipes. They can be molded into many shapes, including intricate small parts, and can be drawn into thin fibers. Some can be foamed to produce high-bulk materials such as styrofoam, further increasing their thermal insulation properties. Plastics have become a critical material in the modern economy; in 1979 the annual volume of plastics produced exceeded the volume of steel that was manufactured.

Growing demand for consumer products and convenience products, such as processed foods and beverages, is enhancing demand for plastic packaging on a worldwide basis. Meanwhile, makers of many components in major commercial and consumer products, from automobiles to computers, are switching to plastics due to the durability, light weight and long life of plastic. Growth in the plastics sector is so rapid that total world consumption of plastic materials is forecast to nearly double from 2003 through 2015, as demand is growing at more than a 5% annual rate. As industry leader BASF puts it, "In brief, plastics will be the materials of the 21st Century." Global consumption of plastics is now in excess of 180 million metric tons (almost 400 billion pounds) yearly.

Hand out 2b. How Plastics Are Made

Read on 8/27/08 http://www.epa.gov/msw/plastic.htm

Plastics are polymers. The most simple definition of a polymer is something made up of many units. Polymers are chains of molecules. Each link of the chain is usually made of carbon, hydrogen, oxygen, and/or silicon. To make the chain, many links, are hooked, or polymerized, together.

To create polymers, petroleum and other products are heated under controlled conditions and broken down into smaller molecules called monomers. These monomers are the building blocks for polymers. Different combinations of monomers produce plastic resins with different characteristics, such as strength or molding capability.

Plastics can be divided into two major categories: thermosets and thermoplastics. A thermoset is polymer that solidifies or "sets" irreversibly when heated. They are useful for their durability and strength, and are therefore used primarily in automobiles and construction applications. Other uses are adhesives, inks, and coatings.

A thermoplastic is a polymer in which the molecules are held together by weak bonds, creating plastics that soften when exposed to heat and return to original condition at room temperature. Thermoplastics can easily be shaped and molded into products such as milk jugs, floor coverings, credit cards, and carpet fibers.

Plastic resins are processed in several ways, including extrusion, injection molding, blow molding, and rotational molding. All of these processes involve using heat and/or pressure to form plastic resin into useful products, such as containers or plastic film.

Plastic composites are mixtures of plastics and fibers, fillers, particulates, powders and other reinforcements, The resultant material has improved strength and can be shaped freely into a variety of products like car interiors, furniture, etc

Bio-based Plastics

Read 8/27/08 http://www.soynewuses.org/Plastics/Default.aspx

Soy Based Polyurethanes using soy polyols include urethane foams, binders, coatings, adhesives and sealants to be used as carpet-backing agents, spray-foam insulations, body panels on agricultural equipment and other products. SoyTherm and Argol are insulation materials that are free of volatile organic compounds (VOCs), formaldehyde and asbestos.

Soy Based Plastic Composites present another exciting segment for soy. Technology in this area includes plastic body and interior parts for automobiles, boats and even agricultural equipment used to harvest soybeans and other oilseed crops. This full-circle usage could potentially replace an estimated 300 million pounds of all thermoset resins in a market totaling 2.7 billion pounds per year in North America alone.

Corn Based Plastics – The Nebraska Corn Board reported that Cargill Corporation was able to develop corn-based polylactic acid (PLA), which is now being used to produce a variety of products. One example is a complete line of compostable tableware made entirely from corn. The line includes disposable forks, knives, spoons, plates, cups, bowls, and storage containers such as those used in deli's and supermarkets. The PLA-products completely degrade in a composting environment. One major chain of natural food stores, Wild Oats Markets of Boulder, CO, has switched its packaging to PLA with great acceptance and support from its customers. PLA clothing items are also being introduced, and bedding made from PLA can be purchased in several department stores across Nebraska and the nation. In Japan, consumers can buy a Sony-Walkman and CD's made from corn-based PLA. Fujitsu sells a laptop computer with a PLA casing.

Hand out 3. Plastic Recycling in the US

Read 8/27/07 http://www.greenerchoices.org/products.cfm?product=plastic&pcat=homegarden

The challenge

-Plastic production is up. A record amount of plastic was produced in the U.S. in 2004, a total of about 115 billion pounds, according to the American Plastics Council.

-Most plastic is made from nonrenewable resources. Plastics are typically made from fossil fuels, including oil and natural gas.

-Plastic waste is increasing. The amount of plastic in municipal solid waste has increased from less than 1 % of the total in 1960 to 11 % in 2003, according to the U.S. Environmental Protection Agency.

-Plastic recycling rates are down. The recycling rate of the most widely collected type of plastic (#1-PET) has dropped by about a third in the last decade, from one in three containers being recycled in 1995 to about one in five in 2004, according to the Container Recycling Institute. This means that, of the 50 billion single-serve beverage bottles expected to be used in 2005, about 40 billion will end up in landfills or as litter.

The opportunity

-We have the capacity. According to the American Plastics Council, we're only using 25% of our nation's recycling capacity. That means the plastic you put out at the curb or drop off at a local facility is most likely being recycled, as promised, and there's room for a lot more.

-There is a market for recycled plastics. Once collected and sorted, plastic is processed into small pellets or flakes and sold to manufacturers, which then use it to create new plastic products. The majority of collected plastic, #1-PET and #2-HDPE bottles and containers, is turned into fiber, including carpet and clothing, as well as nonfood containers, including detergent, motor oil, and household cleaner bottles. To learn more about recycled plastics, see the table below.

Seven Misconceptions about Plastic and Plastic Recycling

Plastics Task Force, California

Read on 8/25/08 **http://www.ecologycenter.org/ptf/misconceptions.html**

Misconception # 1: *Plastics that go into a curbside recycling bin get recycled.* Not necessarily. Plastic collected at the curb are made into textiles, parking lot bumpers, or plastic lumber – all un-recyclable products. This does not reduce the use of virgin materials in plastic packaging

Misconception # 2: Curbside *collection will reduce the amount of plastic land-filled.* Not necessarily. If establishing collection makes plastic packages seem more environmentally friendly, people may feel comfortable buying more.

Misconception # 3: *A "chasing arrows" symbol means a plastic container is recyclable*. The arrows are meaningless. The only information in the symbol is the number inside the arrows, which indicates the general class of resin used to make the container, not its potential to be recycled.

Misconception # 4: *Packaging resins are made from petroleum refineries' waste*. Plastic resins are made from non-renewable natural resources that could be used for a variety of other applications or conserved. Most packaging plastics are made from the same natural gas used in homes for heating and cooking.

Misconception # 5: *Plastics recyclers pay to promote plastics' recyclability*. No; virgin resin producers pay for the bulk of these ads to promote plastic sales. These advertisements are aimed at removing our negative public perception of plastic as un-recyclable and environmentally harmful.

Misconception # 6: *Using plastic containers conserves energy*. When the equation includes the energy used to synthesize the plastic resin, making plastic containers uses as much energy as making glass containers from virgin materials, and much more than making glass containers from recycled materials.

Misconception # 7: *Our choice is limited to recycling or wasting*. Source reduction is preferable for many types of plastic and isn't difficult. Opportunities include using refillable containers, buying in bulk, buying things that don't need much packaging, and buying things in recyclable and recycled packages.

Plastic Resin Types and Uses After Recycling

Poly-Ethylene Terephthalate (PET)
The most common type of plastic, PET is used in soft drink bottles, containers for ice, water, liquor, cooking oil, food condiments, mouthwash and cleaning products. It may be recycled into food containers, filling for jackets and sleeping bags, bathtubs, swimming pools, and other plastic items.

High Density Polyethylene (HDPE)
Another plastic with many uses, this type is often found in milk jugs, yogurt and film containers, grocery bags, gasoline tanks, detergent bottles, toys, pipes, and 55 gallon drums. It may be recycled into toys, plastic lumber, mud flaps, flower pats, grocery bags, sheet plastic and containers.

Polyvinyl Chloride (PVC)
Though frequently used, PVC is more difficult to recycle than numbers 1 and 2. Pressure pipe, surgical gloves, clear food packaging and house siding are all made from this plastic.

Low Density Polyethylene (LDPE)
This plastic type is often seen as bread packaging, frozen food bags, toys, paint can lids and milk bottle caps.

Polypropylene (PP)
Polypropylene plastic is widely used in food containers, yarns, fabrics, upholstery, luggage and car seats.

Polystyrene (PS)

With a very wide range of uses, this resin is used to make everything from video cassettes and TVs to egg cartons and fast food packaging.

All Other Resins

Various other resin types and multi-layered material form this last group.

Hand out 4a. Pollution by Plastics

Read on 8/28/07 http://www.plasticdebris.org/PRDS_Brochure_DOWNLOAD.pdf

The Plastic Debris, Rivers to Sea Project seeks to minimize the land-based discharges of marine debris. Just like ocean-based marine debris, land-based discharges of human-made debris are comprised mostly of plastics.

Plastic and synthetic materials are the most common types of marine debris and cause the most problems for marine animals and birds. At least 267 different species are known to have suffered from entanglement or ingestion of marine debris including seabirds, turtles, seals, sea lions, whales and fish.

The scale of contamination of the marine environment by plastic debris is vast. It is found floating in all the world's oceans, everywhere from polar regions to the equator. The seabed, especially near to coastal regions, is also contaminated – predominantly with plastic bags. Plastic is also ubiquitous on beaches everywhere from populous regions to the shores of very remote uninhabited islands.

The threat and impacts of marine debris have long been ignored. Perhaps it is the perceived vastness of ocean and lack of visibility of marine debris to most people that has allowed society to dismiss the problem as a serious threat. However, recent research demonstrates that quantities and impacts of marine debris are significant and increasing. The Algalita Marine Research Foundation's investigation of plastic in the North Pacific Central Gyre of the Pacific Ocean showed that the mass of plastic pieces was six times greater than zooplankton floating on the water's surface. This study is one of many that demonstrate that *our oceans have become the virtual garbage can for human societies*.

Most of the marine debris in the world is comprised of plastic materials. The average proportion varies between 60 to 80% of total marine debris. In many regions, plastic materials constitute as much as 90 to 95% of the total amount of marine debris.

Nearly 80% of marine debris comes from land-based sources. Most of the land-based debris is conveyed to oceans via urban runoff through storm drains. The main sources of plastic and other types of anthropogenic (human-made) debris in urban runoff include: litter (mostly bags, packaging and single-use disposable products), industrial discharges, garbage transportation, landfills, construction debris, and debris from commercial establishments and public venues.

Read on 8/27/07 http://www.treehugger.com/files/2007/07/plastic_pollution.php
In India, the ubiquitous cows supposedly eat anything and they really do – from paper to banana peels. And in the stomach of one deceased cow, it was discovered that it had ingested about 35 kg (77 lbs.) of plastic. Worldwide, the statistics of plastic use indicate that perhaps it's time for some change in attitudes elsewhere as well: typical annual plastic use per person in India is 2 kg (4.4 lbs); in Europe it's 60 kg (132 lbs) and in the U.S. it's an astonishing 80 kg (176 lbs).

Plastics manufacturers contribute to air pollution because they burn fossil fuels in order to run their facilities. Some industries producing plastics have been cited for violations of air quality regulations. Plastics litter the landscape, even in remote villages all over the Earth.

Hand out 4b --The Problem with Plastic

Read on 8/27/07 http://www.botany.uwc.ac.za/Envfacts/plastic/index.htm

Since the development of plastic earlier this century, it has become a popular material used in a wide variety of ways. Today plastic is used to make, or wrap around, many of the items we buy or use. The problem comes when we no longer want these items and how we dispose of them, particularly the throwaway plastic material used in wrapping or packaging. Plastics are used because they are easy and cheap to make and they can last a long time. Unfortunately these same useful qualities can make plastic a huge pollution problem. The cheapness means plastic gets discarded easily and its long life means it survives in the environment for long periods where it can do great harm. Because plastic does not decompose and requires high energy ultra-violet light to break down, the amount of plastic waste in our oceans is steadily increasing.

Surveys of 50 South African beaches show that in five years from 1984 to 1989 plastic pollution increased by 190%. More than 90% of the man-made articles found on these beaches contained plastic. Plastic is now found on virtually all South African beaches, even the most remote, and researchers are now also finding plastic rubbish in Antarctic regions.

The plastic rubbish found on beaches near urban areas tends to originate from use on land, such as packaging material used to wrap around other goods. On remote rural beaches the rubbish tends to have come from ships, such as fishing equipment used in the fishing industry or discarded garbage.

The Threat to wildlife

Plastic can affect marine wildlife in two important ways: by entangling creatures and by being eaten.

Turtles: Turtles are particularly badly affected by plastic pollution, and all seven of the world's turtle species are already either endangered or threatened for a number of reasons. Turtles get entangled in fishing nets, and many sea turtles have been found dead with plastic bags in their stomachs. It is believed they mistake these floating semi-transparent bags for jellyfish and eat them. The turtles die from choking or from being unable to eat. One dead turtle found off Hawaii in the Pacific was found to have more than 1000 pieces of plastic in its stomach including part of a comb, a toy truck wheel and nylon rope.

Marine Mammals: There is great concern about the effect of plastic rubbish on marine mammals in particular, because many of these creatures are already under threat for a variety of other reasons)e.g. whale populations have been decimated by uncontrolled hunting). A recent US report concluded that 100,000 marine mammals die each year in the world's oceans by eating or becoming entangled in plastic rubbish, and the situation is worsening. When a marine mammal such as a Cape fur seal gets caught up in a large piece of plastic, it may simply drown, or become exhausted and die of starvation due to the greater effort needed to swim; or the plastic may kill slowly over a period of months or years as it bites into the animal causing wounds, loss of blood and/or severing of limbs.

"Ghost Nets": A large number of marine creatures become trapped and killed in "ghost nets". These are pieces of gill nets which have been lost by fishing vessels. Other pieces of lost fishing equipment such as lobster pots may also keep trapping creatures.

Marine Birds: World-wide, 75 marine bird species are known to eat plastic articles. This includes 36 species found off South Africa. A recent study of blue petrel chicks at South Africa's remote Marion Island showed that 90% of chicks examined had plastic in their stomachs apparently fed to them accidentally by their parents. South African seabirds are among the worst affected in the world. Plastics may remain in the stomachs, blocking digestion and possibly causing starvation. As particular species seem to be more seriously affected, this may be a threat to whole populations of these birds.

Hand out 5. Adverse Health Effects of Plastics

Read on 8/27/07 http://www.ecologycenter.org/factsheets/plastichealtheffects.html#plastichealthgrid

In addition to creating safety problems during production, many chemical additives that give plastic products desirable performance properties also have negative environmental and human health effects. These effects include

- Direct toxicity, as in the cases of lead, cadmium, and mercury associated with plastics
- Carcinogens, as in the case of diethylhexyl phthalate (DEHP)
- Endocrine disruption, which can lead to cancers, birth defects, immune system suppression and developmental problems in children.

Chemical Migration from Plastic Packaging into Contents

People are exposed to these chemicals not only during manufacturing, but also by using plastic packages, because some chemicals migrate from the plastic packaging to the foods they contain. Examples of plastics contaminating food have been reported with most plastic types, including Styrene from polystyrene, plasticizers from PVC, antioxidants from polyethylene, and acetaldehyde from PET.

Among the factors controlling migration are the chemical structure of the migrants and the nature of the packaged food. In studies cited in Food Additives and Contaminants, LDPE, HDPE, and polypropylene bottles released measurable levels of BHT, Chimassorb 81, Irganox PS 800, Irganix 1076, and Irganox 1010 into their contents of vegetable oil and ethanol. Evidence was also found that acetaldehyde migrated out of PET and into water.

Recommendations

- Buy food in glass or metal containers
- Avoid heating food in plastic containers, or storing fatty foods in plastic containers or plastic wrap
- Do not give young children plastic teethers or toys
- Use natural fiber clothing, bedding and furniture
- Avoid all PVC and styrene products

Plastic	*Common Uses*	*Adverse Health Effects*
Polyvinyl chloride (#3PVC)	Food packaging, plastic wrap, containers for toiletries, cosmetics, crib bumpers, floor tiles, pacifiers, shower curtains, toys, water pipes, garden hoses, auto upholstery, inflatable swimming pools	Can cause cancer, birth defects, genetic changes, chronic bronchitis, ulcers, skin diseases, deafness, vision failure, indigestion, and liver dysfunction
Phthalates (DEHP, DINP, and others)	Softened vinyl products manufactured with phthalates include vinyl clothing, emulsion paint, footwear, printing inks, non-mouthing toys and children's products, product packaging and food wrap, vinyl flooring, blood bags and tubing, IV containers and components, surgical gloves, breathing tubes, general purpose lab equipment, inhalation masks, many other medical devices	Endocrine disruption, linked to asthma, developmental and reprductive effects. Medical waste with PVC and pthalates is regularly incinerated causing public health effects from the release of dioxins and mercury, including cancer, birth defects, hormonal changes, declining sperm counts, infertility, endometriosis, and immune system impairment.

Polycarbonate, with Bisphenol A (#7)	Water bottles	Scientists have linked very low doses of bisphenol A exposure to cancers, impaired immune function, early onset of puberty, obesity, diabetes, and hyperactivity, among other problems (Environment California)
Polystyrene	Many food containers for meats, fish, cheeses, yogurt, foam and clear clamshell containers, foam and rigid plates, clear bakery containers, packaging "peanuts", foam packaging, audio cassette housings, CD cases, disposable cutlery, building insulation, flotation devices, ice buckets, wall tile, paints, serving trays, throw-away hot drink cups, toys	Can irritate eyes, nose and throat and can cause dizziness and unconsciousness. Migrates into food and stores in body fat. Elevated rates of lymphatic and hematopoietic cancers for workers.
Polyethelyne (#1 PET)	Water and soda bottles, carpet fiber, chewing gum, coffee stirrers, drinking glasses, food containers and wrappers, heat-sealed plastic packaging, kitchenware, plastic bags, squeeze bottles, toys	Suspected human carcinogen
Polyester	Bedding, clothing, disposable diapers, food packaging, tampons, upholstery	Can cause eye and respiratory-tract irritation and acute skin rashes
Urea-formaldehyde	Particle board, plywood, building insulation, fabric finishes	Formaldehyde is a suspected carcinogen and has been shown to cause birth defects and genetic changes. Inhaling formaldehyde can cause cough, swelling of the throat, watery eyes, breathing problems, headaches, rashes, tiredness
Polyurethane Foam	Cushions, mattresses, pillows	Bronchitis, coughing, skin and eye problems. Can release toluene diisocyanate which can produce severe lung problems
Acrylic	Clothing, blankets, carpets made from acrylic fibers, adhesives, contact lenses, dentures, floor waxes, food preparation equipment, disposable diapers, sanitary napkins, paints	Can cause breathing difficulties, vomiting, diarrhea, nausea, weakness, headache and fatigue
Tetrafluoro-ethelyne	Non-stick coating on cookware, clothes irons, ironing board covers, plumbing and tools	Can irritate eyes, nose and throat and can cause breathing difficulties

Hand out 6a. Plastics in the News

Google News 8/27/08

Hold the (**plastic**) **bag**
The Times of Trenton - NJ.com, NJ - 21 hours ago
Overseas, Ireland has sharply reduced the use of **plastic bags** by placing a small tax on them, and in France, Paris will **ban** the **bags** by the end of the year. **...**

Labor **plastic bag ban** 'wacky'
NEWS.com.au, Australia - Aug 15, 2007
By Peter Veness A LABOR plan to **ban plastic bags** if it wins the election has been labelled "wacky" by the Government. Opposition environment spokesman Peter **...**

Town that **banned bags** touts golf carts
Canada.com, Canada - Aug 23, 2007
The tiny town in northern Manitoba that was first in Canada to **ban plastic** shopping **bags** is now turning its attention to gas-powered vehicles. **...**

PCC Natural Market to get rid of **plastic bags** for good
KOMO, WA - Aug 23, 2007
Michael Johnson, who runs Polybag LLC, says any **plastic-bag ban** unfairly targets his industry. "They (big companies) have done study after study and spent **...**

Oakland sued over **plastic bag ban**
San Jose Mercury News, USA - Aug 9, 2007
An advocacy group that includes **bag** manufacturers and recyclers has sued to overturn a city-approved **ban** on **plastic** grocery **bags**. An Alameda Superior Court **...**

Fairfax won't back down over **bag ban**
Marin Independent-Journal, CA - Aug 20, 2007
By Rob Rogers Fairfax leaders say they plan to fight legal challenges to the town's **ban** on **plastic** grocery **bags**. "For us to cave into a whining plastics **...**

Village aims to **ban plastic bags**
BBC News, UK - Aug 16, 2007
Modbury in Devon became one of the first places in the UK to introduce a voluntary **ban** on **plastic bags** when all 43 traders and shops in the market town **...**

Sewing bees fight **plastic bags**, raise funds for library
San Diego Union Tribune, United States - Aug 22, 2007
Plastic grocery **bag** litter has become so bothersome that Ireland, Taiwan, South Africa, Australia, Italy and Bangladesh have taxed the **bags** or **banned** their **...**

NGO declares war on **plastic**
Calcutta Telegraph, India - 4 hours ago
Senior planning officer Rajani Kanta Deka laid out an action plan to combat the use of **plastic bags**. The world's annual consumption of **plastic** materials has **...**

Sainsbury's trial **plastic bag ban** in
Retail Bulletin, UK - Aug 13, 2007
Sainsbury's' move follows an announcement from Waitrose last month that it was trialling a **plastic bag ban** in two stores. Plus, the new trial follows an **...**

Handout 6b. Plastic Bags Bans in the U.S.

Read on 8/27/07 http://www.nj.com/opinion/times/editorials/index.ssf?/base/news-0/11881876593800.xml&coll=5

The Times of Trenton, NJ
Hold the (plastic) bag
Monday, August 27, 2007

Plastic bags -- there're everywhere. They wind up on the kitchen table and chairs after shopping; they skip along urban streets and pristine pastures like tumbleweeds; and they cling to trees like tent caterpillar cocoons.

Yes, the ubiquitous plastic bag is so much a part of our lives that we hardly give the convenience store souvenir a scintilla of thought. But plastic bags merit our attention because they now account for a sizable part of the unsightly litter that spoils our vistas and clogs our landfills with substances that environmentalists fear may release dangerous toxins during the many years it takes the plastic to degrade.

Worldwide, about 100 billion plastic bags are sold each year, according to the Film and Bag Federation, a trade group within the Society of the Plastics Industry based in Washington, D.C. Millions of barrels of oil are used to make the bags.

The top four manufacturers of plastic bags have formed an alliance to promote recycling and the proper use of the bags. San Francisco has gone so far as to ban non-compostable bags at large supermarkets. Other cities such as Boston, Baltimore and Portland, OR., are looking at similar measures. Overseas, Ireland has sharply reduced the use of plastic bags by placing a small tax on them, and in France, Paris will ban the bags by the end of the year.

Unfortunately, this environmental issue is not getting much attention from New Jersey lawmakers.

So, what is the alternative to using plastic bags to carry home our purchases? Forget about paper. Compared to plastic, the production of paper bags requires more energy and water and creates more air pollution. Paper bags also take up more landfill space.

The answer is really very simple: Take along a reusable bag made of canvas or some other sturdy, environmentally friendly material when shopping.

The idea seems to be catching on. Whole Foods, a trendy grocery chain, set off a frenzy when it started selling $15 cotton shopping bags designed by London-based designer Anya Hindmarch. The bags, which proclaim, "I'm not a plastic bag," were being offered on eBay last month for more than $130.

Some enterprising business person or retail chain will probably see the advertising potential of reusable bags, which could carry store logos or ads. The bags could be offered to shoppers for a nominal charge.

Getting shoppers to use these "green" bags may take a bit of persuasion. Here is where we urge commercial interests to get behind the concept. A little bit of a nudge from state lawmakers wouldn't hurt, either.

Note; in Syracuse, NY, Home Depot, and Wegmans stores sell reusable bags for less than 2 dollars.

Read on 9/14/2007 http://thetyee.ca/Views/2006/07/26/PlasticSea/
Views
Today: Saturday, September 1, 2007
The Plastic Sea

Worse than oil spills?

An ocean awash in lethal bags, bottles, pellets, line, tarps and diapers.

By Paul Watson
Published: July 26, 2006

TheTyee.ca

On the beach on San Juan Island, Washington, Allison Lance walks her dogs every morning. She carries a plastic bag in her hand to carry the bits and pieces of plastic debris she picks up. Each morning she fills the bag, but by the next morning there is always another bag to be filled. Joey Racano does the same in Huntington Beach further south in California. The harvest of plastic waste is never-ending. Allison's and Joey's beaches, and practically every beach around the world, is similarly cursed.

Recently in the Galapagos I retrieved plastic motor oil bottles and garbage bags from a remote beach on Santa Cruz Island. Every year during crossings of the Pacific, Atlantic and Indian Oceans, spotting plastic is a daily and regular occurrence.

A June 2006 United Nations environmental program report estimated that there are an average of 46,000 pieces of plastic debris floating on or near the surface of every square mile of ocean.

We live in a plastic convenience culture; virtually every human being on this planet uses plastic materials directly and indirectly every single day. Our babies begin life on Earth by using some 210 million pounds of plastic diaper liners each year; we give them plastic milk bottles and plastic toys, and buy their food in plastic jars, paying with a plastic credit card. Even avoiding those babies by using contraceptives results in mass disposal of billions of latex condoms, diaphragms, and hard plastic birth control pill containers each year.

Every year we eat and drink from some 34 billion newly manufactured bottles and containers. We patronize fast food restaurants and buy products that consume another 14 billion pounds of plastic. In total, our societies produce an estimated 60 billion tons of plastic material every year.

Each of us on average uses 190 pounds of plastic annually: bottled water, fast food packaging, furniture, syringes, computers and computer diskettes, packing materials, garbage bags and so much more. When you consider that this plastic does not biodegrade and remains in our ecosystems permanently, we are looking at an incredibly high volume of accumulated plastic trash that has been built up since the mid-20th century. Where does it go? There are only three places it can go: our earth, our air and our oceans.

Styrofoam foam

All the plastic that has ever been produced has been buried in landfills, incinerated and dumped into lakes, rivers and oceans. When incinerated, the plastics disperse non-biodegradable pollutants, much of which inevitably finds its way into marine ecosystems as microscopic particles.

Back in 1991, my ship, the *Sea Shepherd*, was anchored in the harbour of Port of Spain, Trinidad. It began to rain a hard, steady downpour. A few hours later, the entire surface area of the harbour was dirty white, as if an ice floe had entered this tropical port. The "floe" consisted of Styrofoam, plastic bottles and assorted plastic materials, as far as the eye could see, and it had come down from the streets, gutters and streams into the harbour. And, of course, it was all washing out to sea, dispersed by wind and tide.

What happened to it after that? The sun and the brine broke it down into little pellets of Styrofoam and little pieces of plastic -- each an insidious, floating, deadly mine set adrift in an ocean of life.

And over the years these little nodules have drifted. Many have been ingested by birds and fish. Weeks or months later, the victims decompose on the surface of the water or on a beach, re-exposing the nodules to the light of the sun, to be blown by the winds back into the sea. These vicious little inorganic parasites continue to maim and kill in an endless assault upon life in our oceans.

The simple fact is that when you drop a Styrofoam cup onto the street, you're causing more damage than you would by dropping a stick of dynamite into the ocean. You set in motion an invasion of thousands of killer plastibots that will cause death and destruction for centuries to come.

Eighteen billion of those disposable diapers end up in the oceans each year; Americans alone toss 2.5 million plastic bottles into the sea every hour. Our oceans are full of floating plastic debris. There is no place in the oceans where a fine trawl will not reveal plastic nodules. Studies by Captain Charles Moore and the Algalita Foundation found that even in the middle of the Pacific Ocean, plastic nodules have been found to outweigh plankton by a ratio of six to one. Similar studies in the Atlantic have revealed the same ratio.

Floating out of mind

In the movie *Castaway*, Tom Hanks, marooned on a desert island in the South Pacific, finds a plastic siding of a portable outhouse washed up on the beach. The stuff is everywhere. I have found plastic bottles with Japanese, Chinese, Russian and English writing littering the beaches of even the most remote Aleutian Islands.

And yet we give this global threat very little thought at all. It is out of the sight of land-dwelling humanity, and thus out of mind. The only industry that seems concerned about plastic pollution is the marine insurance business. The intake of plastics into the cooling systems of engines is one of the leading causes of maritime engine failures. Last year, Japanese insurance companies paid $50 million in claims involving plastic-related engine and prop damage.

Drifting in our seas are tens of thousands of miles of monofilament ghost drift nets and lines. This same netting ensnares ship props and the necks of sea lions and turtles. Over the years, my crew has retrieved hundreds of floating monofilament nets from the sea. All of them contained the rotting corpses of fish and birds.

In a well-documented beach clean-up in Orange County, California, volunteers collected 106 million items, weighing 13 tons. The debris included preproduction plastic pellets, foamed plastics and hard plastics; plastic constituted 99 per cent of the total material collected. The most abundant item found on the beaches of Orange County was preproduction plastic pellets, most of which originated from transport losses. Approximately one quadrillion of these pellets, or 60 billion pounds, are manufactured annually in the United States alone. You never hear about these spillages in the newspaper, and there is not a single plastic pellet spillage response crew anywhere in the world.

The plastic products that end up in the sea because of consumers constitute less than 30 per cent of the total plastics dumped into the oceans each year. The greater amount comes from accidental spillage of plastic resin pellets produced by the petrochemical industry for the purpose of manufacturing consumer plastic products, or the breakdown of finished products into Styrofoam nodules or hard plastic particles. Plastic nodules are lost routinely in both the shipping and manufacturing stages, spilling from shipboard containers or from trucks onto streets and into storm drains.

Lethal threat

Oil spills occur every day in our oceans, and major spills occur on average every two weeks somewhere in the world's marine ecosystem. Although these oil spills are notorious killers of marine wildlife, their deadly impact is confined to relatively small areas geographically, and the impact is reduced with time. The Exxon Valdez spill, for example, was confined to Alaska's Prince William Sound, and although the impact on wildlife was felt for many years, the ecosystem is slowly recovering. Yet this other kind of petrochemical spill is more invasive and permanent. This type of spill is cumulative. The spillage is never cleaned up and removed, but accumulates perpetually.

I don't think that I am exaggerating when I say that the spillage of plastic resin pellets poses a significant and unappreciated threat to the survival of sea life. The oceans are becoming plasticized. This threat becomes more lethal each year as the cumulative amount increases. The impact of this spillage contributes to more casualties than all of the world's annual oil spills, yet we know very little about the problem. In fact, the public does not even recognize plastic resin pellet spillage as a problem at all.

Plastic pellets also pose an additional threat. They act as a transport medium for toxic chemicals. Many of these pellets contain polychlorinated biphenyls (PCBs). The chemicals were either absorbed from ambient seawater or used in the manufacture of plasticizers prior to the 1970s. This transfer of PCBs from ingested pellets into birds was conclusively proven and documented in the fatty tissues of great shearwaters (Puffinus gravis). Studies have shown that 75 per cent of all shearwaters examined contained ingested plastic.

Of 312 species of seabirds, some 111 species, or 36 per cent, are known to mistakenly ingest plastic. In Hawaii, 16 of the 18 resident seabird species are plastic ingestors, and 70 per cent of this ingestion is of floating plastic resin pellets. Seabirds in Alaska have been found to have stomachs entirely filled with indigestible plastic. Penguins on South African beaches have suffered high chick mortality from eating plastic regurgitated by the parents, and 90 per cent of blue petrel chicks examined on South Africa's remote Marion Island had plastic particles in their stomachs. It is a global problem, and for seabirds there are no safe places. For most people, the ocean is a big toilet. The belief is that garbage, sewage and plastics are dispersed and taken away.

Garbage 'gyres'

Unfortunately, nothing is really ever "taken away"; it is simply perpetually circulated. The oceans are pulsating with powerful currents, and these currents keep plastic debris in constant circulation. As a result, debris travels in what are called "gyres." The gyre concentrates the garbage in areas where currents meet. For example, one of the largest of these movements in the Atlantic is called the central gyre, and it moves in a clockwise circular pattern driven by the Gulf Stream. The central gyre concentrates heavily in the northern Sargasso Sea, a place that is also host to numerous spawning fish species.

The number of floating plastic pellets found in the Sargasso Sea has been measured in excess of 3,500 parts per square kilometer. The same ratio of 3,500 parts per square kilometer was found in the waters of the southern coasts of Africa. This study found that plastic pollution had increased in South African waters from 1989 to the present by 190 per cent.

Birds, turtles and fish mistake the tiny nodules for fish eggs. Garbage bags, plastic soda rings and Styrofoam particles are regularly eaten by sea turtles. A floating garbage bag looks like a jellyfish to a

turtle. The plastic clogs the turtle's intestines, robbing the animals of vital nutrients, and has been the cause of untold turtle losses to starvation. All seven of the world's sea turtle species suffer mortality from both plastic ingestion and plastic entanglement. One turtle found dead off Hawaii carried over 1,000 pieces of plastic in its stomach and intestines. And recently, a land-based turtle rescued in a Florida waterway by Stephen Nordlinger was unable to submerge due to the amount of Styrofoam trapped in its body, making it permanently buoyant.

Plastic floor

The amount of plastic pellets present on beaches is astonishingly high. In New Zealand, one beach was found to contain over 100,000 pellets per square meter. Thus, it is not so far-fetched to suggest that people are in fact sunbathing on plastic beaches -- literally. I have stopped my ship mid-ocean and found flip-flops, suntan oil bottles, plastic Coke bottles, garbage bags and even large floating industrial plastic sheets. In each place sampled, we have also found plastic pellets.

Once, on the bottom of the Mediterranean off France, I witnessed a scene that appalled me. The entire bottom was made of plastic. Bottles and plastic bags swaying with the tide, replacing the sea grasses and algae. It was especially sad to see one little fish scurry from behind a white plastic bag to take cover from me in a sunken automobile tire. Brushing aside another drifting white bag, I spied a flicker of red on the bottom. What I found was a plastic face staring up at me with a great big smile and two enormous plastic ears. It was the decapitated head of a Mickey Mouse doll.

It's a plastic sea out there.

Paul Watson is founder of the Sea Shepherd Conservation Society, a co-founder of Greenpeace International and the Greenpeace Foundation, was National Director of the Sierra Club USA and is Director of the Farley Mowat Institute.